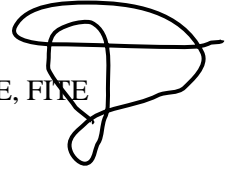


MEMORANDUM

TO: Mr. Michael P. Gilleberto
Town Administrator
Town of Tyngsborough
25 Bryants Lane
Tyngsborough, MA 01879

FROM: Mr. Jeffrey S. Dirk, P.E., PTOE, FITE
Principal
Vanasse & Associates, Inc.
10 New England Business Center Drive
Suite 314
Andover, MA 01810-1066
(978) 474-8800 x830
jdirk@rdva.com



DATE: January 31, 2014

RE: 6598

SUBJECT: Intersection Safety and Operations Assessment
Westford Road at Dunstable Road
Tyngsborough, Massachusetts

Vanasse & Associates, Inc. (VAI) has been retained by the Town of Tyngsborough to conduct an Intersection Safety and Operations Assessment for the intersection of Westford Road at Dunstable Road (a.k.a. Flint's Corner) in Tyngsborough, Massachusetts. The purpose of this assessment is to evaluate potential improvement strategies for the intersection that would accomplish the following objectives: i) facilitate the efficient flow of vehicles, pedestrians and bicyclists; ii) accommodate existing and projected future traffic volumes; and iii) enhance safety at the intersection. The improvement strategies that have been identified for the subject intersection have been designed in accordance with Massachusetts Department of Transportation (MassDOT) standards and follow MassDOT's "Complete Streets" and "GreenDOT" design policies with respect to accommodating all roadway users. As such, the recommended improvements are designed to be eligible for funding through the State Transportation Improvement Program (STIP).

This study was prepared in consultation with the Town of Tyngsborough and MassDOT; was performed in general accordance with the Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs (EEA)/MassDOT Guidelines for Environmental Impact Report/Environmental Impact Statement Traffic Impact Assessments (TIAs) and the MassDOT standards for the preparation of Traffic Impact Assessments for Functional Design Reports (FDRs); and was conducted pursuant to the standards of the Traffic Engineering and Transportation Planning professions for the preparation of such reports.

As a result of this assessment, it has been recommended that the Town's *Lane Use Modification* design be implemented at the intersection of Westford Road at Dunstable Road as a short-term (immediate) improvement measure, and that Intersection Improvement Alternative 2 – *Westford Road Geometric Modifications*, be considered for implementation as a long-term improvement strategy in order to improve traffic operations and safety under both existing and projected future traffic volume conditions. Both improvement strategies (short and long-term) include the development of an optimal traffic signal timing and phasing plan to accompany the recommended geometric modifications.

The following details our assessment of improvement strategies for the intersection of Westford Road at Dunstable Road.



EXISTING CONDITIONS

A comprehensive field inventory of existing conditions within the study area was conducted in October and November 2013. The field investigation consisted of an inventory of existing roadway geometrics; pedestrian and bicycle facilities; public transportation services; traffic volumes; and operating characteristics; as well as posted speed limits and land use information within the study area. The study area is depicted on Figure 1 and consisted of the intersection of Westford Road at Dunstable Road and its associated approaches.

The following describes existing conditions within the study area.

Roadways

Westford Road



Westford Road is a two-lane, urban minor arterial roadway¹ that is under Town jurisdiction and traverses the study area in a general northeast-southwest direction between Middlesex Road (Route 3A) and Teeney Road. Westford Road provides access to Route 3 by way of a partial cloverleaf type interchange (Exit 34) located northeast of Dunstable Road. Within the immediate study area, Westford Road provides two (2) 11 to 27-foot wide travel lanes separated by a double-yellow centerline with 2 to 11-foot

wide marked shoulders provided and additional turning lanes provided at major intersections. Sidewalks are not provided along Westford Road within the study area. The posted speed limit along Westford Road within the study area is 35 miles per hour (mph). Land use along Westford Road consists of residential and commercial properties, and areas of open and wooded space.

Dunstable Road



Dunstable Road is a two-lane roadway under Town jurisdiction that traverses the study area in a general northwest-southeast direction between Cummings Road and Makepeace Road, and is classified as an urban minor arterial roadway north of Westford Road and as an urban collector roadway to the south. Within the immediate study area, Dunstable Road provides two (2) 10 to 14-foot wide travel lanes separated by a double-yellow centerline with variable width or no marked shoulders provided. Sidewalks

are not provided along Dunstable Road within the study area. The posted speed limit along Dunstable Road within the study area is 35 mph. Land use along Dunstable Road consists of residential and commercial properties, and areas of open and wooded space.

¹Roadway functional classifications defined by the MassDOT Office of Transportation Planning.



Figure 1

Project Location Map



Vanasse & Associates, Inc.
Transportation Engineers & Planners

Intersection

Westford Road at Dunstable Road



Dunstable Road intersects Westford Road from the northwest and southeast to form this four-legged intersection under traffic signal control located approximately 1/3 of a mile southwest of the Route 3/Westford Road interchange. Existing intersection attributes are as follows:

- Four-legged intersection under traffic signal control
- Westford Road northeastbound approach provides a single general-purpose travel lane (12 feet wide)
- Westford Road southwestbound approach provides a left-turn/through travel lane (12-feet wide) and a right-turn lane (13 feet wide)
- Dunstable Road approaches provides a single general-purpose travel lane (12-feet wide)
- Posted speed limit on all approaches to the intersection is 35 mph
- Sidewalks are not provided along the intersecting roadways
- Marked crosswalks are not provided at the intersection
- The traffic signal operates in a two-phase, fully actuated mode and is coordinated with the traffic signals to the northeast at the Route 3/Westford Road interchange
- Land use in the vicinity of the intersection consists of residential and commercial properties, and areas of open and wooded space

Existing Traffic Volumes

In order to determine existing traffic-volume demands and flow patterns within the study area, automatic traffic recorder (ATR) counts, manual turning movement counts (TMCs) and vehicle classification counts were completed in October 2013. The ATR counts were conducted on Westford Road northeast of Dunstable Road in order to record weekday and Saturday daily traffic conditions over an extended period, with weekday morning (7:00 to 9:00 AM) and evening (4:00 to 6:00 PM) peak-period manual TMC's performed at the Westford Road/Dunstable Road intersection. These time periods were selected for analysis purposes as they are representative of the peak traffic volume hours for both Westford Road and Dunstable Road. Traffic volumes on a Saturday were found to be generally lower than those experienced on a weekday.

Traffic Volume Adjustments

In order to evaluate the potential for seasonal fluctuation of traffic volumes within the study area, MassDOT weekday seasonal factors for Group 6 roadways (urban arterials, collectors and rural arterials, the functional classification of both Westford Road and Dunstable Road) were reviewed.² Based on a review of this data, it was determined that traffic volumes for the month of October are approximately 7 percent above average-month conditions. As such, the traffic volume data that forms the basis of this assessment was not adjusted downward in order to provide a conservative (above-average) analysis condition. The 2013 Existing traffic volumes are summarized in Table 1, with the weekday morning and evening peak-hour traffic volumes graphically depicted on Figure 2.

As can be seen in Table 1, Westford Road, northeast of Dunstable Road, was found to accommodate approximately 17,685 vehicles on an average weekday (two-way, 24-hour volume), with approximately 1,566 vehicles per hour (vph) during the weekday morning peak-hour and 1,833 vph during the weekday evening peak-hour. On a Saturday, this segment of Westford Road was found to accommodate approximately 15,595 vehicles, with approximately 1,346 vph during the Saturday midday peak-hour.

Pedestrian and Bicycle Facilities

A comprehensive field inventory of pedestrian and bicycle facilities within the study area was undertaken in November 2013. The field inventory consisted of a review of the location of sidewalks and pedestrian crossing locations at the study intersection, as well as the location of existing and proposed bicycle facilities. Sidewalks are not provided along either Westford Road or Dunstable Road, nor are marked crosswalks provided at the Westford Road/Dunstable Road intersection.

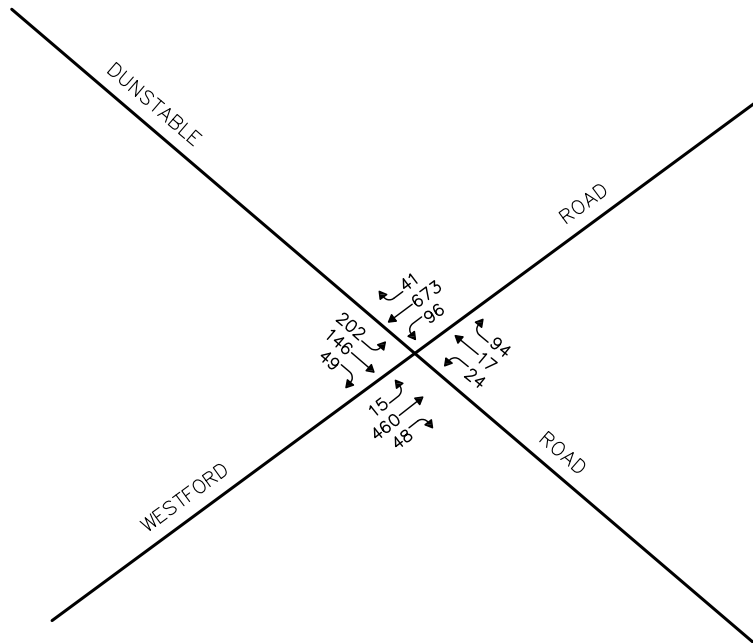
At present, no formal existing bicycle facilities were identified within the immediate study area. Further, neither Westford Road nor Dunstable Road provides sufficient width on a continuous basis to support bicycle travel in a shared travelled-way condition (i.e., bicycle and motor vehicle sharing the travelled-way).³

²MassDOT Traffic Volumes for the Commonwealth of Massachusetts; 2007 Weekday Seasonal Factors, Group 6 – Urban Arterials, Collectors and Rural Arterials.

³The minimum width required to support bicycle travel in a shared travelled-way configuration is 14-feet consisting of the travel lane and shoulder area where present.



WEEKDAY MORNING PEAK HOUR
(7:15 - 8:15 AM)



WEEKDAY EVENING PEAK HOUR
(5:00 - 6:00 PM)

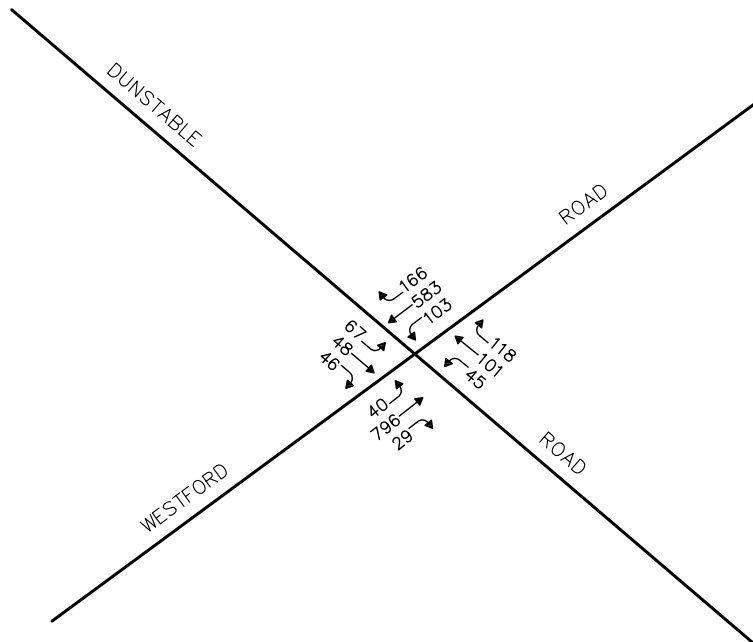


Figure 2

**2013 Existing
Peak Hour Traffic Volumes**

Table 1
2013 EXISTING TRAFFIC VOLUMES

Location	AWT ^a	Weekday Morning Peak-Hour (7:15 – 8:15 AM)			Weekday Evening Peak-Hour (5:00 – 6:00 PM)			Saturday ^e	Saturday Midday Peak-Hour (11:00 AM – 12:00 PM)		
		VPH ^b	K Factor ^c	Directional Distribution ^d	VPH	K Factor	Directional Distribution		VPH	K Factor	Directional Distribution
Westford Road, east of Dunstable Road	17,685	1,566	8.9	51.7% SWB	1,833	10.4	53.5% NEB	15,595	1,346	8.6	57.6% NEB

^aAverage weekday traffic in vehicles per day.

^bVehicles per hour.

^cPercent of daily traffic occurring during the peak hour.

^dPercent traveling in peak direction.

^eAverage Saturday traffic in vehicles.

NEB = northeastbound; SWB = southwestbound.

Public Transportation Services

At present, the Town of Tyngsborough is not served by regularly scheduled public transportation services. The Lowell Regional Transit Authority (LRTA) does provide paratransit service to the Town through the Council on Aging by way of its Road Runner service. The Road Runner paratransit service is available to eligible persons with disabilities who are unable to use the LRTA fixed-route bus service. All vehicles are equipped to provide service to individuals with wheelchairs or other mobility devices. The LRTA Road Runner service operates during the same hours as the LRTA fixed route bus service, but does not operate during some holidays and during extreme weather events. Reservations can be made up to one day prior and cancellations are required at least one hour in advance. Fares are \$1.00 for in-town transport and \$1.50 for out of town destinations.

Spot Speed Measurements

Vehicle travel speed measurements were performed on Westford Road within the study area over a continuous 72-hour period (Thursday through Saturday) in conjunction with the ATR counts. Table 2 summarizes the vehicle travel speed measurements.

Table 2
VEHICLE TRAVEL SPEED MEASUREMENTS

	Westford Road	
	Eastbound	Westbound
Mean Travel Speed (mph)	38	33
85 th Percentile Speed (mph)	42	39
Posted Speed Limit (mph)	35	35

mph = miles per hour.

As can be seen in Table 2, the mean (average) vehicle travel speed along Westford Road within the study area was found to be approximately 36 mph. The average measured 85th percentile vehicle travel speed, or the speed at which 85 percent of the observed vehicles traveled at or below, was found to be approximately 41 mph, or 6 mph above the posted speed limit of 35 mph. The 85th percentile speed is used as the basis of engineering design and in the evaluation of sight distances, and is often used in establishing posted speed limits. The detailed speed measurements are provided in the Appendix.

Motor Vehicle Crash Data

Motor vehicle crash information for the intersection of Westford Road at Dunstable Road was provided by the MassDOT Highway Division Safety Management/Traffic Operations Unit for the most recent five-year period available (2007 through 2011, inclusive) in order to examine motor vehicle crash trends occurring at the intersection. The data is summarized by type, severity, and day of occurrence, and presented in Table 3.



Table 3
MOTOR VEHICLE CRASH DATA SUMMARY^a

	Westford Road/ Dunstable Road
Traffic Control Type: ^b	TS
<i>Year:</i>	
2007	6
2008	5
2009	3
2010	5
<u>2011</u>	<u>3</u>
Total	22
Average	4.40
Calculated Crash Rate ^c	0.52
MassDOT Crash Rate	0.77
Significant? ^d	No
<i>Severity:</i>	
Property Damage Only	17
Personal Injury	5
Fatal	0
<u>Unknown</u>	<u>0</u>
Total	22
<i>Type:</i>	
Angle	7
Rear-End	10
Head-On	1
Fixed Object	1
Sideswipe Same Direction	1
Sideswipe Opposite Direction	2
<u>Unknown/Other</u>	<u>0</u>
Total	22
<i>Weather Conditions:</i>	
Clear	16
Cloudy	3
Rain	2
Snow/Ice	1
<u>Unknown</u>	<u>0</u>
Total	22
<i>Lighting</i>	
Daylight	20
Dawn/Dusk	0
Dark (Road Lit)	2
Dark (Road Unlit)	0
Dark (No Street Lights)	0
<u>Other/Unknown</u>	<u>0</u>
Total	22
<i>Day of Week:</i>	
Monday through Friday	18
Saturday	3
<u>Sunday</u>	<u>1</u>
Total	22

^aSource: MassDOT Highway Division Safety Management/Traffic Operations Unit 2007 through 2011.

^bTraffic Control Type: TS = Traffic Signal.

^cCrash rate per million vehicles entering the intersection.

^dThe intersection crash rate is significant if it is found to exceed MassDOT Crash Rate for the MassDOT Highway Division District in which the intersection is located (District 4).

As can be seen in Table 3, the intersection of Westford Road at Dunstable Road was found to have experienced a total of 22 reported motor vehicle crashes over the five-year review period, or approximately four (4) crashes per year. The majority of the reported crashes involved property damage only; occurred on a weekday during daylight under clear weather conditions; and were reported as rear-end-type collisions. The calculated crash rate at the intersection (average number of motor vehicle crashes reported per year per million vehicles travelling through the intersection) was found to be below the MassDOT average for a signalized intersection for the MassDOT Highway Division District in which the intersection is located (District 4). As such, the MassDOT data did not indicate a discernible safety deficiency with respect to the design or operation of the intersection. No fatal motor vehicle crashes were reported at the intersection over the five-year review period. The detailed MassDOT Crash Rate Worksheet is provided in the Appendix.

Existing Traffic Operations

In order to evaluate existing traffic operations at the study intersection, a detailed traffic operations analysis was completed under 2013 Existing traffic volume conditions. In brief, six levels of service are defined for each type of facility. They are given letter designations ranging from “A” to “F”, with a level-of-service (LOS) “A” representing the best operating conditions and a LOS “F” representing congested or constrained operations. A LOS “E” is representative of a transportation facility that is operating at its design capacity with a LOS “D” generally defined as the limit of “acceptable” traffic operations. Since the level-of-service of a traffic facility is a function of the flows placed upon it, such a facility may operate at a wide range of levels of service depending on the time of day, day of week, or period of the year. The Synchro™ intersection capacity analysis software, which is based on the analysis methodologies and procedures presented in the 2010 *Highway Capacity Manual* (HCM),⁴ was used to complete the level-of-service and vehicle queue analyses, the results of which are summarized in Table 4.

As can be seen in Table 4, the intersection of Westford Road at Dunstable Road was found to be operating under constrained conditions (defined as LOS “F”) during both the weekday morning and evening peak-hours under 2013 Existing traffic volume and geometric conditions. In particular, both Westford Road approaches were found to be operating at or over capacity (defined as LOS “E” or “F”, respectively) during the peak hours, with the exception of the right-turn movement from Westford Road southwestbound to Dunstable Road, which was found to be operating at LOS “A”. Both Dunstable Road approaches were found to be operating under acceptable conditions (defined as a LOS “D” or better); however, vehicle queuing on the southeastbound approach was shown to range from 11 to 18 vehicles during the weekday morning peak-hour.

⁴*Highway Capacity Manual*, Transportation Research Board; Washington, DC; 2010.

Table 4
TRAFFIC OPERATIONS ANALYSIS SUMMARY
WESTFORD ROAD AT DUNSTABLE ROAD

Peak Hour/Movement	2013 Existing Existing Geometry			
	V/C ^a	Delay ^b	LOS ^c	Queue ^d 50 th / 95 th
<i>Weekday Morning:</i>				
Westford Road NEB LT/TH/RT	0.95	55.3	E	11/16
Westford Road SWB LT	--	--	--	--
Westford Road SWB LT/TH	2.07	>80.0	F	26/31
Westford Road SWB TH/RT	--	--	--	--
Westford Road SWB RT	0.06	9.6	A	0/1
Dunstable Road NWB LT/TH/RT	0.25	23.4	C	1/3
Dunstable Road SEB LT/TH/RT	0.83	41.3	D	11/18
Overall	--	>80.0	F	--
<i>Weekday Evening:</i>				
Westford Road NEB LT/TH/RT	1.57	>80.0	F	11/19
Westford Road SWB LT	--	--	--	--
Westford Road SWB LT/TH	1.30	>80.0	F	10/21
Westford Road SWB TH/RT	--	--	--	--
Westford Road SWB RT	0.17	5.2	A	0/1
Dunstable Road NWB LT/TH/RT	0.71	30.9	C	5/8
Dunstable Road SEB LT/TH/RT	0.51	26.8	C	3/5
Overall	--	>80.0	F	--

^aVolume-to-capacity ratio.

^bAverage delay per vehicle (in seconds).

^cLevel-of-Service.

^dQueue length in vehicle.

NEB = northeastbound; NWB = northwestbound; SEB = southeastbound; SWB = southwestbound;
 LT = left-turning movements; TH = through movements; RT = right-turning movements.

SIGHT DISTANCE EVALUATION

Sight distance measurements were performed at the Westford Road/Dunstable Road intersection in accordance with MassDOT and American Association of State Highway and Transportation Officials (AASHTO)⁵ requirements. Both stopping sight distance (SSD) and intersection sight distance (ISD) measurements were performed. In brief, SSD is the distance required by a vehicle traveling at the design speed of a roadway, on wet pavement, to stop prior to striking an object in its travel path. ISD or corner sight distance (CSD) is the sight distance required by a driver entering or crossing an intersecting roadway to perceive an on-coming vehicle and safely complete a turning or crossing maneuver with on-coming traffic. In accordance with AASHTO standards, if the measured ISD is at least equal to the required SSD value for the appropriate design speed, the intersection can operate in a safe manner. Table 5 presents the measured SSD and ISD at the subject intersection.

⁵A Policy on Geometric Design of Highway and Streets, 6th Edition; American Association of State Highway and Transportation Officials (AASHTO); 2011.

Table 5
SIGHT DISTANCE MEASUREMENTS^a

Intersection/Sight Distance Measurement	Feet		
	Required Minimum	ISD ^b	Measured
<i>Westford Road at Dunstable Road</i>			
<i>Stopping Sight Distance:</i>			
Westford Road approaching from the east	360	--	400+
Westford Road approaching from the west	360	--	500+
Dunstable Road approaching from the north	305	--	500+
Dunstable Road approaching from the south	305	--	500+
<i>Intersection Sight Distance:</i>			
Looking to the east from Dunstable Road northbound	360	430/500	500+
Looking to the west from Dunstable Road northbound	360	430/500	500+
Looking to the east from Dunstable Road southbound	360	430/500	500+
Looking to the west from Dunstable Road southbound	360	430/500	500+

^aRecommended minimum values obtained from *A Policy on Geometric Design of Highways and Streets*, 6th Edition; American Association of State Highway and Transportation Officials (AASHTO); 2011; and based on a 45 mph approach speed on Westford Road and a 40 mph approach speed on Dunstable Road.

^bValues shown are the intersection sight distance for a vehicle turning right/left exiting a roadway under STOP control such that motorists approaching the intersection on the major street should not need to adjust their travel speed to less than 70 percent of their initial approach speed.

As can be seen in Table 5, the available lines of sight at the Westford Road/Dunstable Road intersection were found to exceed the required minimum sight distances for the intersection to operate in a safe and efficient manner based on the appropriate approach speed.

FUTURE CONDITIONS

Traffic volumes in the study area were projected to the year 2020, which reflects a seven-year planning horizon from current year consistent with MassDOT guidelines for the preparation of Traffic Impact Assessments for Functional Design Reports (FDRs). Traffic volumes on the roadway network in the year 2020 under Design-Year conditions include all existing traffic and new traffic resulting from background traffic growth and specific development projects in the area.

Specific Development Projects

The Planning Board of the Town of Tyngsborough was contacted in order to determine if there were any projects planned within the study area that would have an impact on future traffic volumes at the study intersection. Based on this discussion, the following projects were identified for inclusion in this assessment:

- ***Wynbrook Residential Development, Tyngsborough, Massachusetts.*** This project consists of the construction of 96 single-family homes for persons age 55 or older located along the north side of Westford Road, south of Dunstable Road, in Tyngsborough, Massachusetts. This project was approximately 50 percent complete and occupied at the time of the traffic data collection that forms the basis of this assessment (October 2013).



- ***Mixed-Use Development, Tyngsborough, Massachusetts.*** This project consists of the construction of a 1,600 square foot (sf) Honey Dew Donuts/Subway sandwich shop and a 10,005 sf childcare facility to be located at 81 Westford Road in Tyngsborough, Massachusetts.
- ***Tyngsborough Commons Mixed-Use Development, Tyngsborough, Massachusetts.*** This proposed project consists of the construction of approximately 200,000 sf of industrial office space, 150 residential condominium units, and 126,200 sf of retail/office space to be located at 50 Westford Road in Tyngsborough, Massachusetts.

Traffic volumes associated with the aforementioned development projects by others were either estimated using trip-generation statistics published by Institute of Transportation Engineers (ITE)⁶ for the appropriate land uses or were obtained from the traffic study conducted for the specific development, and were assigned onto the study area roadway network based on existing traffic patterns where no other information was available. No other developments were identified at this time that are expected to result in an increase in traffic within the study area beyond the background traffic growth rate. The relevant background development traffic volume networks are provided in the Appendix.

General Background Traffic Growth

Historic traffic-volume data provided by the Town of Tyngsborough for the intersection of Westford Road at Dunstable Road from 1993 and the recently collected 2013 traffic volume data were reviewed in order to determine general background traffic growth trends. Based on a review of this data, it was determined that traffic volumes within the study area have generally increased by approximately 2.2 percent over the past twenty years. In order to provide a conservative (high) analysis scenario and a prudent planning condition for review of potential improvement strategies at the subject intersection, a 2.2 percent per year compounded annual background traffic growth rate was used in order to account for future traffic growth and presently unforeseen development within the study area, consistent with the historic traffic growth rate experienced at the intersection.

Design-Year Traffic Volumes

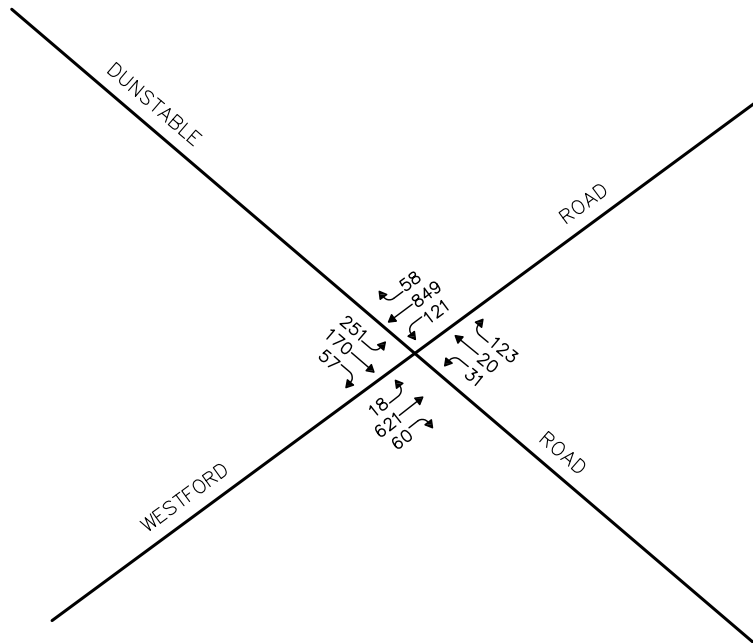
The 2020 Design-Year peak-hour traffic volumes were developed by: i) applying the 2.2 percent per year compounded annual background traffic growth rate to the 2013 Existing peak-hour traffic volumes; and ii) superimposing the peak-hour traffic volumes expected to be generated by the identified specific development projects. The resulting 2020 Design-Year weekday morning and evening peak-hour traffic volumes are depicted on Figure 3.

INTERSECTION IMPROVEMENT ALTERNATIVES AND ANALYSIS

Based on a review of existing and projected future traffic volume conditions, one (1) short-term and three (3) long-term improvement strategies were identified for evaluation for the intersection of Westford Road at Dunstable Road. The short-term improvement strategy would entail restriping the Westford Road southwestbound approach to provide a left-turn lane and a through/right-turn lane. The long-term improvement strategies were separated into three (3) alternatives as follows: Alternative 1 - provide a left-turn lane on the Westford Road southwestbound and Dunstable Road southeastbound approaches; Alternative 2 - provide two general-purpose travel lanes on both Westford Road approaches; and Alternative 3 - provide two general-purpose travel lanes on both Westford Road approaches and a left-turn lane on the Dunstable Road southeastbound approach. A detailed assessment of each of

⁶*Trip Generation*, 9th Edition; Institute of Transportation Engineers; Washington, DC; 2012.

WEEKDAY MORNING PEAK HOUR
(7:15 - 8:15 AM)



WEEKDAY EVENING PEAK HOUR
(5:00 - 6:00 PM)

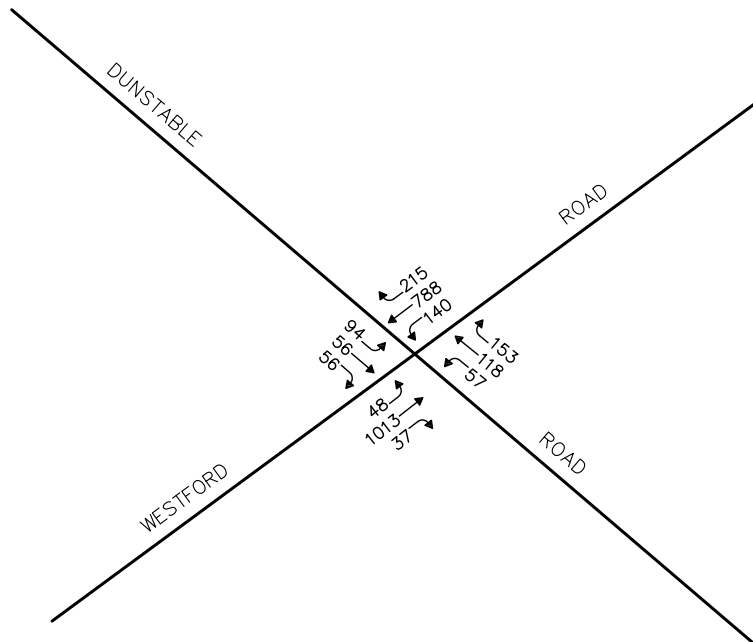


Figure 3

**2020 Design Year
Peak Hour Traffic Volumes**

identified intersection improvement strategies was completed with respect to their ability to: i) facilitate the efficient flow of vehicles, pedestrians and bicyclists; ii) accommodate existing and projected future traffic volumes at the intersection; and iii) enhance safety. The following summarizes our assessment of the study intersection under existing geometric and traffic control conditions, and with implementation of the short-term and potential long-term intersection improvement strategies. Preliminary cost estimates also provided for each alternative.

Existing Intersection Geometry

As can be seen in Table 7, under 2020 Design-Year conditions, absent improvement, the intersection of Westford Road at Dunstable Road was shown to continue to operate at an overall LOS F during both the weekday morning and evening peak hours with vehicle queues ranging from 0 to 46 vehicles.

Short-Term Improvement Strategy

Westford Road Lane Use Modification

Recognizing the immediate need for improvements at the Westford Road/Dunstable Road intersection, the Town of Tyngsborough evaluated a short-term improvement measure that would entail restriping the Westford Road southwestbound approach to accommodate a left-turn lane and a through/right-turn lane (vs. a left-turn/through travel lane and a right-turn lane) with associated modifications to the traffic signal system. These improvements are shown on Figure 4 and have been assessed in relation to both 2013 Existing traffic volume conditions given the potential near-term implementation of the improvements and 2020 Design-Year traffic volume conditions to determine potential long-term benefits. The results of the analysis are summarized in Table 6 for 2013 traffic volume conditions and in Table 7 for 2020 Design-Year conditions. For comparison purposes, Table 6 also presents the 2013 Existing conditions analysis that was summarized in Table 4.

As can be seen in Table 6, with the suggested lane use modifications and the associated implementation of an optimal traffic signal timing and phasing plan, the improved intersection was shown to operate at an overall LOS “C” during both weekday morning and evening peak hours, with no movement found to be operating below LOS “D”. Vehicle queues on the intersection approaches were shown to range from 1 to 27 vehicles during the peak periods. These operating conditions represent a significant improvement over current intersection operations.

As can be seen in Table 7, under 2020 Design-Year conditions, the short-term improvements will have exceeded their design capacity, with LOS “F” operating conditions predicted to reoccur during both the weekday morning and evening peak hours, and vehicle queues ranging from 1 to 44 vehicles.

The estimated cost to design and construct the short-term improvements as depicted on Figure 4 is \$20,000.

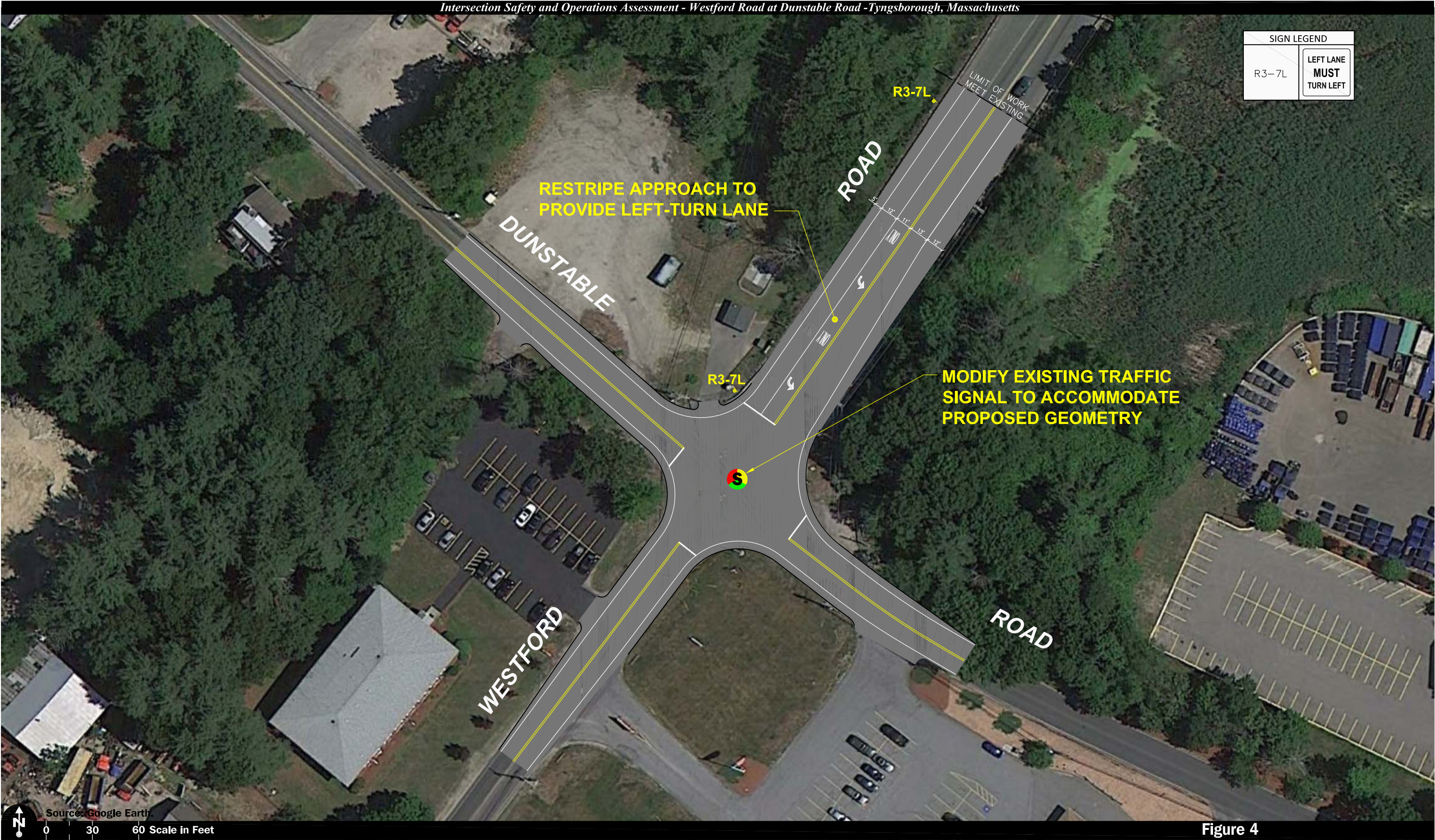


Figure 4
Westford Road Lane Use
Modification

Table 6
TRAFFIC OPERATIONS ANALYSIS SUMMARY
WESTFORD ROAD AT DUNSTABLE ROAD

Peak Hour/Movement	2013 Existing Intersection Geometry				2013 Existing With Short-Term Improvement Strategy			
	V/C ^a	Delay ^b	LOS ^c	Queue ^d 50 th / 95 th	V/C	Delay	LOS	Queue 50 th / 95 th
<i>Weekday Morning:</i>								
Westford Road NEB LT/TH/RT	0.95	55.3	E	11/16	0.68	24.4	C	12/17
Westford Road SWB LT	--	--	--	--	0.35	16.6	B	2/2
Westford Road SWB LT/TH	2.07	>80.0	F	26/31	--	--	--	--
Westford Road SWB TH/RT	--	--	--	--	0.81	23.8	C	17/20
Westford Road SWB RT	0.06	9.6	A	0/1	--	--	--	--
Dunstable Road NWB LT/TH/RT	0.25	23.4	C	1/3	0.25	23.8	C	1/3
Dunstable Road SEB LT/TH/RT	0.83	41.3	D	11/18	0.84	43.3	D	11/18
Overall	--	>80.0	F	--	--	27.7	C	--
<i>Weekday Evening:</i>								
Westford Road NEB LT/TH/RT	1.57	>80.0	F	11/19	0.95	33.3	C	12/27
Westford Road SWB LT	--	--	--	--	0.45	13.7	B	1/2
Westford Road SWB LT/TH	1.30	>80.0	F	10/21	--	--	--	--
Westford Road SWB TH/RT	--	--	--	--	0.75	12.2	B	9/13
Westford Road SWB RT	0.17	5.2	A	0/1	--	--	--	--
Dunstable Road NWB LT/TH/RT	0.71	30.9	C	5/8	0.65	22.1	C	5/8
Dunstable Road SEB LT/TH/RT	0.51	26.8	C	3/5	0.42	19.1	B	3/6
Overall	--	>80.0	F	--	--	22.2	C	--

^aVolume-to-capacity ratio.

^bAverage delay per vehicle (in seconds).

^cLevel-of-Service.

^dQueue length in vehicle.

NEB = northeastbound; NWB = northwestbound; SEB = southeastbound; SWB = southwestbound; LT = left-turning movements;
 TH = through movements; RT = right-turning movements.

Table 7
2020 DESIGN-YEAR TRAFFIC OPERATIONS ANALYSIS SUMMARY
WESTFORD ROAD AT DUNSTABLE ROAD

Peak Hour/Movement	Existing Intersection Geometry				Short-Term Improvement Strategy				Alternative 1 Provide Left-Turn Lane				Alternative 2 Westford Road Geometric Modifications				Alternative 3 Westford Road and Dunstable Road Geometric Modifications			
	V/C ^a	Delay ^b	LOS ^c	Queue ^d 50 th /95 th	V/C ^a	Delay ^b	LOS ^c	Queue ^d 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
<i>Weekday Morning:</i>																				
Westford Road NEB LT/TH/RT	1.37	>80.0	F	25/29	1.33	>80.0	F	29/37	0.77	25.5	C	17/23	0.43	16.7	B	7/8	0.43	14.6	B	5/8
Westford Road SWB LT	--	--	--	--	0.76	40.1	D	2/3	0.63	25.4	C	2/3	--	--	--	--	--	--	--	--
Westford Road SWB LT/TH	2.46	>80.0	F	43/46	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Westford Road SWB TH/RT	--	--	--	--	0.97	39.1	D	25/33	0.95	35.5	D	24/32	--	--	--	--	--	--	--	--
Westford Road SWB LT/TH/RT	--	--	--	--	--	--	--	--	--	--	--	--	0.46	24.4	C	1/2	0.82	29.4	C	13/17
Westford Road SWB RT	0.08	10.3	B	0/1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dunstable Road NWB LT/TH/RT	0.31	23.8	C	1/3	0.36	27.7	C	1/4	0.85	70.2	E	2/6	0.28	20.2	C	1/3	0.33	23.2	C	1/3
Dunstable Road SEB LT	--	--	--	--	--	--	--	--	0.89	56.8	E	6/10	--	--	--	--	0.73	42.5	D	7/11
Dunstable Road SEB LT/TH/RT	1.03	>80.0	F	17/24	1.22	>80.0	F	19/26	--	--	--	--	0.90	47.1	D	14/22	--	--	--	--
Dunstable Road SEB TH/RT	--	--	--	--	--	--	--	--	0.48	29.4	C	5/8	--	--	--	--	0.39	23.8	--	5/7
Overall	--	>80.0	F	--	--	>80.0	F	--	--	36.1	D	--	--	27.5	C	--	--	25.6	C	--
<i>Weekday Evening:</i>																				
Westford Road NEB LT/TH/RT	2.18	>80.0	F	31/41	1.57	>80.0	F	35/44	1.39	>80.0	F	29/39	0.48	9.5	A	6/8	0.50	9.5	A	6/8
Westford Road SWB LT	--	--	--	--	0.74	30.1	C	1/2	1.77	>80.0	F	2/4	--	--	-	--	--	--	--	--
Westford Road SWB LT/TH	1.99	>80.0	F	29/35	--	--	--	--	--	-	--	--	--	--	--	--	--	--	--	--
Westford Road SWB TH/RT	--	--	--	--	0.91	21.4	C	15/29	0.91	21.4	C	15/29	--	--	--	--	--	--	--	--
Westford Road SWB LT/TH/RT	--	--	--	--	--	--	--	--	--	--	--	--	0.50	13.4	B	1/2	0.50	13.4	B	1/2
Westford Road SWB RT	0.22	5.5	A	0/1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dunstable Road NWB LT/TH/RT	0.63	28.9	C	3/5	0.69	35.6	D	3/5	0.73	38.4	D	3/5	0.78	34.6	D	7/11	0.77	34.6	C	7/11
Dunstable Road SEB LT	--	--	--	--	--	--	--	--	0.78	65.3	E	2/5	--	35.9	--	--	0.69	35.9	D	2/5
Dunstable Road SEB LT/TH/RT	0.62	29.0	C	4/8	0.71	37.8	D	4/9	--	--	--	--	0.67	23.1	C	4/9	--	--	--	--
Dunstable Road SEB TH/RT	--	--	--	--	--	--	--	--	0.33	27.4	C	1/3	--	--	--	--	0.25	23.1	C	1/3
Overall	--	>80.0	F	--	--	>80.0	F	--	--	>80.0	F	--	--	17.3	B	--	--	17.5	B	--

^aVolume-to-capacity ratio.
^bAverage delay per vehicle (in seconds).
^cLevel-of-Service.
^dQueue length in vehicle.
NEB = northeastbound; NWB = northwestbound; SEB = southeastbound; SWB = southwestbound; LT = left-turning movements; TH = through movements; RT = right-turning movements.



Long-Term Improvement Alternatives

Alternative 1 – Provide Left-Turn Lanes

Intersection Improvement Alternative 1 would build upon the short-term improvement strategy and would entail restriping the Westford Road southwestbound approach to provide a left-turn lane and a shared through/right-turn lane (vs. a shared left-turn/through travel lane and a right-turn lane) and widening the Dunstable Road southeastbound approach to provide a left-turn lane and a through/right-turn lane. This lane use assignment is reflective of the major turning movements at the intersection during the peak hours and serves to accommodate these movements in separate lanes in order to reduce motorist delay and vehicle queuing. In addition, the existing traffic signal system would be modified to accommodate the proposed geometry. The improvements are depicted on Figure 5 and have been designed to be accommodated within the existing public right-of-way (i.e., no private property acquisitions appear to be required).

As can be seen in Table 7, with Intersection Improvement Alternative 1, operating conditions at the improved signalized intersection were shown to improve over the 2020 Design-Year Base condition (without improvements) to an overall LOS “D” during the weekday morning peak hour but remain operating at LOS “F” during the weekday evening peak hour with reduced overall delays and vehicle queuing.

The estimated cost to design and construct Intersection Improvement Alternative 1 as depicted on Figure 5 is \$820,000.

Alternative 2 – Westford Road Geometric Modifications

Intersection Improvement Alternative 2 would entail widening both Westford Road approaches to provide two general-purpose travel lanes and modifying the existing traffic signal system to accommodate the proposed geometry. This improvement strategy seeks to add travel lanes to accommodate the major flow of traffic at the intersection (Westford Road), and allows for increased allocation of “green” time to the Dunstable Road approaches. The improvements are depicted on Figure 6 and will require the relocation of utility poles and minor private property acquisition(s) to accommodate the widening of Westford Road.

As can be seen in Table 7, with Intersection Improvement Alternative 2, operating conditions at the improved signalized intersection were shown to improve over the 2020 Design-Year Base condition to an overall LOS “C” during the weekday morning peak hour and to LOS “B” during the weekday evening peak hour, with no movement at the intersection shown to operate below LOS “D”.

The estimated cost to design and construct Intersection Improvement Alternative 2 as depicted on Figure 6 is \$910,000, excluding private property acquisition.

Alternative 3 – Westford Road and Dunstable Road Geometric Modifications

Intersection Improvement Alternative 3 expands upon Alternative 2 to incorporate the addition of a left-turn lane on the Dunstable Road southeastbound approach. The addition of the Dunstable Road left-turn lane serves to accommodate the predominant traffic movement on the approach, particularly during the weekday morning peak-hour where the projected left-turn demand is expected to be approximately 250 vehicles. These improvements are depicted on Figure 7 and, similar to Alternative 2, will require the relocation of utility poles and minor private property acquisition(s) to accommodate the widening of Westford Road.

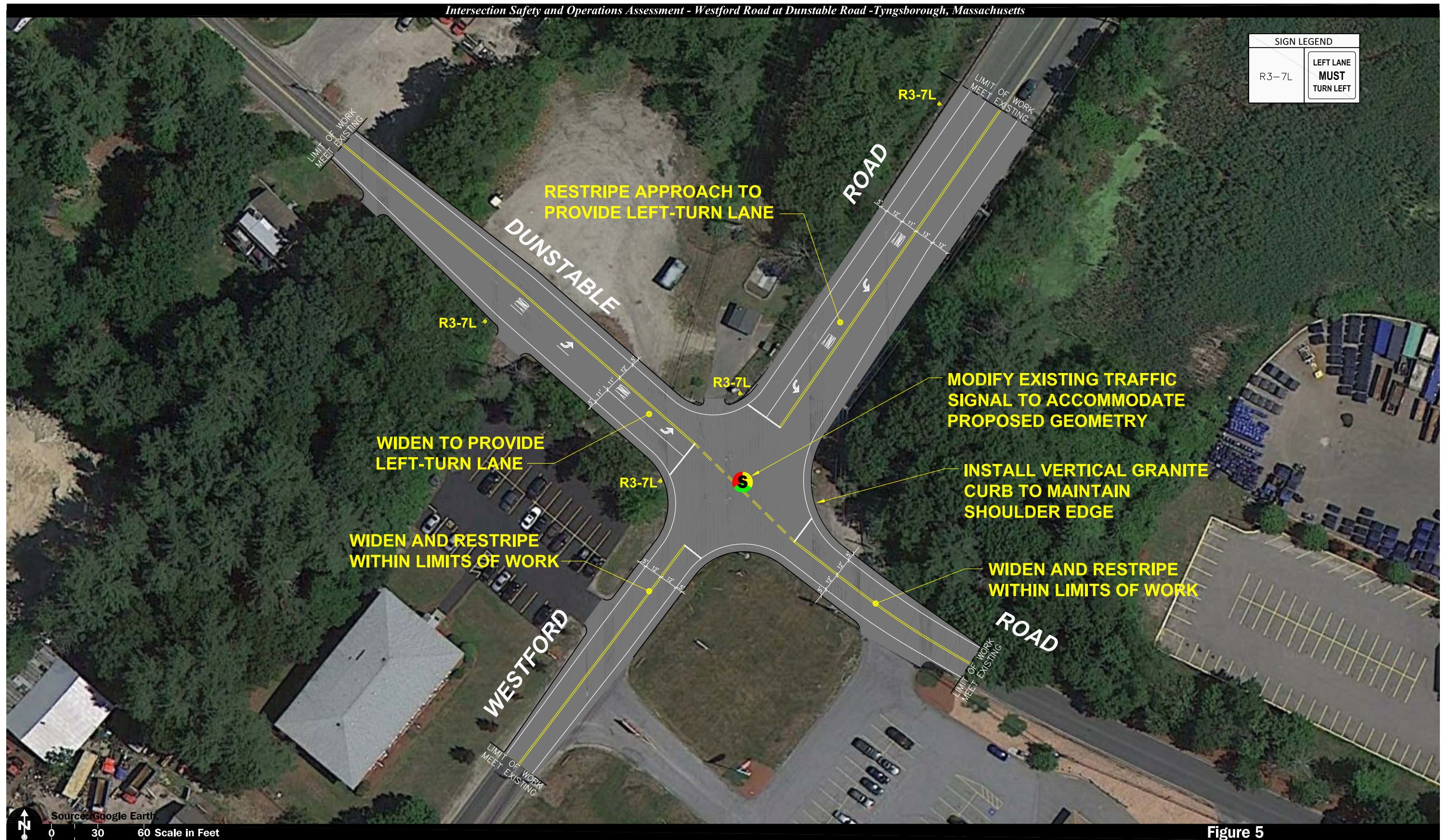


Figure 5

Improvement Alternative 1:
Provide Left-Turn Lanes

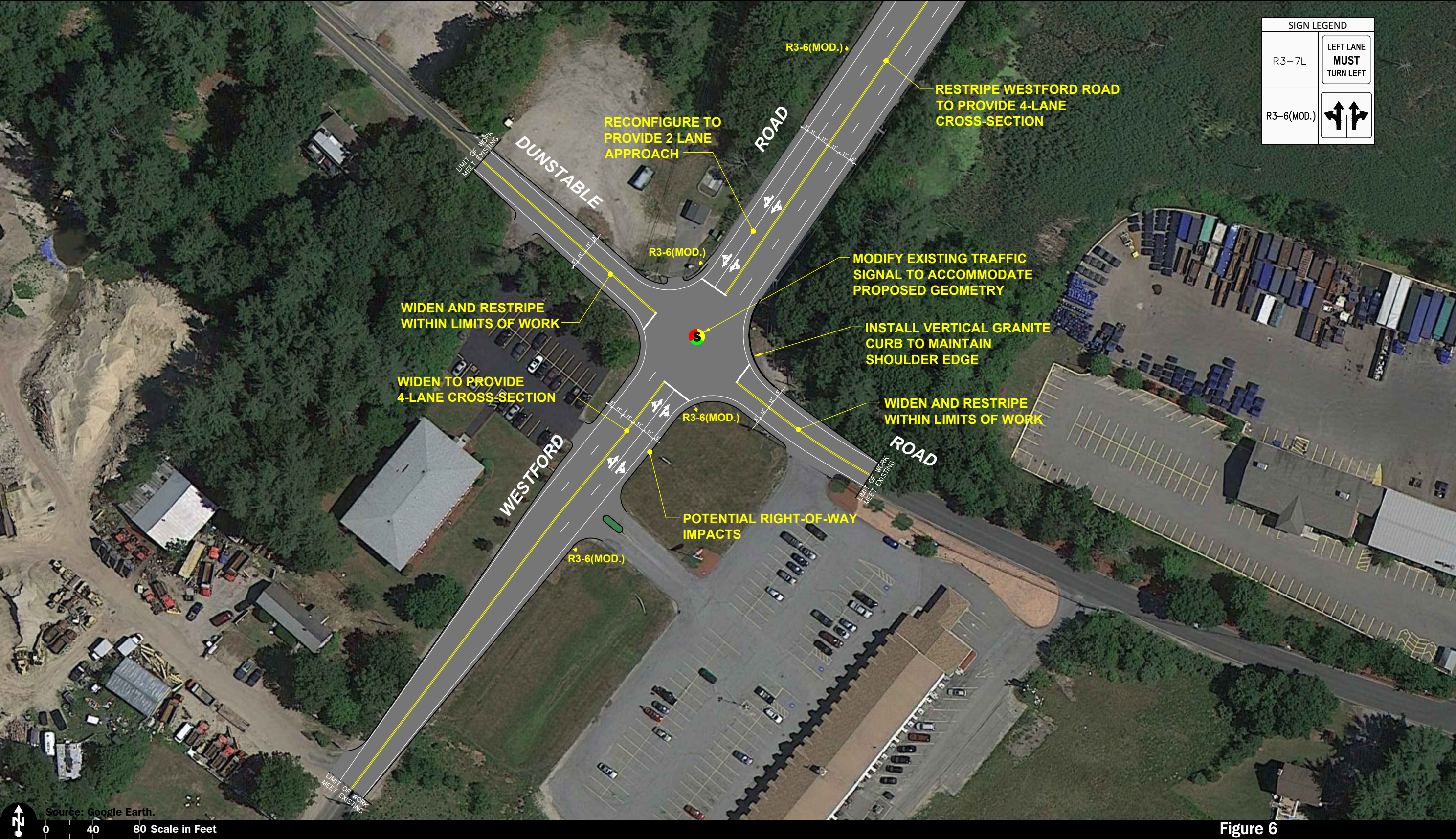


Figure 6
Improvement Alternative 2:
Westford Road
Geometric Modifications

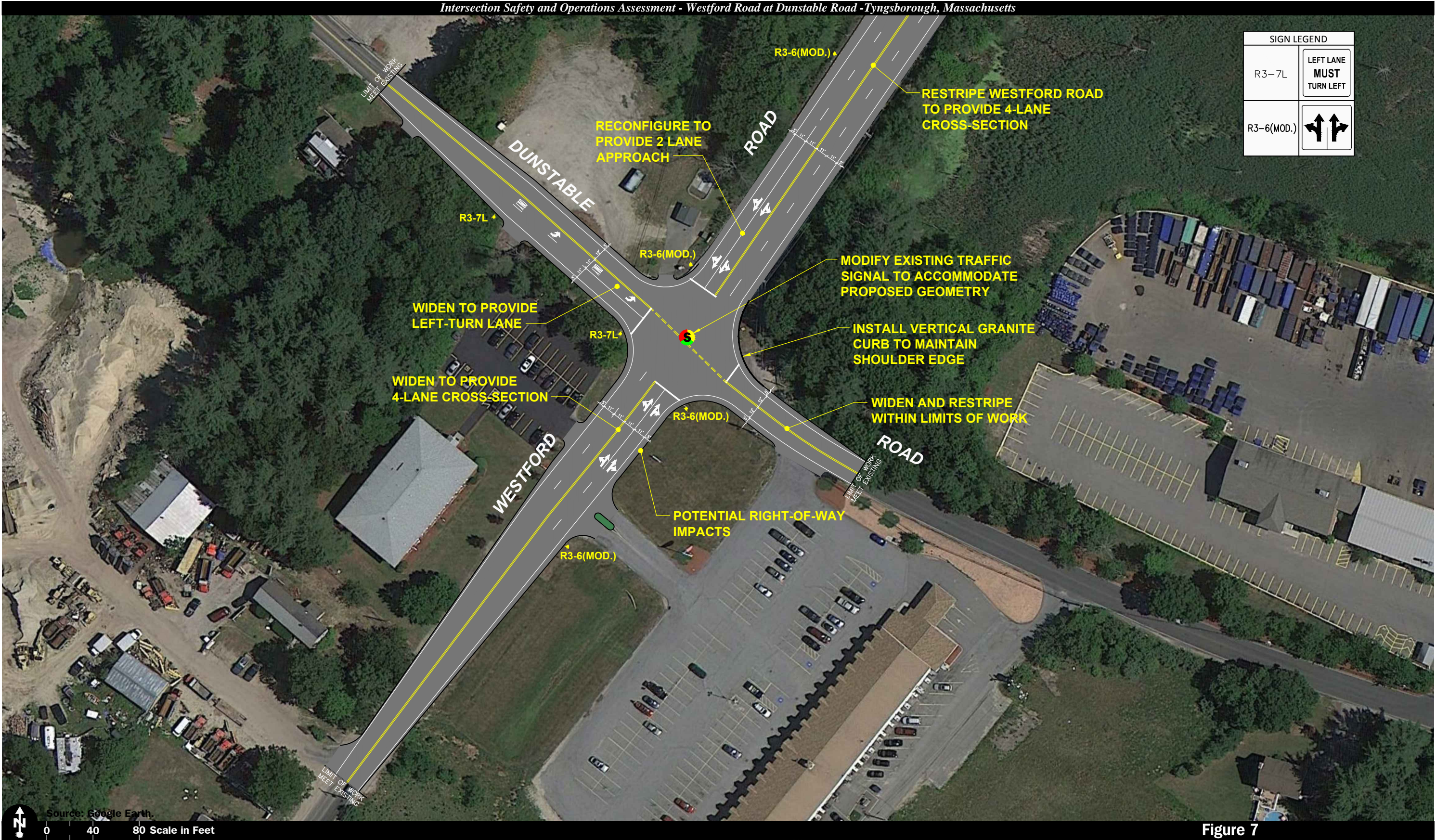


Figure 7
Improvement Alternative 3:
Westford Road and Dunstable Road
Geometric Modifications

As can be seen in Table 7, with Intersection Improvement Alternative 3, operating conditions at the improved signalized intersection was shown to improve over the 2020 Design-Year Base condition to an overall LOS “C” during the weekday morning peak hour and to LOS “B” during the weekday evening peak hour, similar to Alternative 2, with reduced vehicle queuing projected on the Dunstable Road southeastbound approach (an approximate 50 percent reduction over Alternative 2).

The estimated cost to design and construct Intersection Improvement Alternative 3 as depicted on Figure 7 is \$1,180,000, excluding private property acquisition.

PREFERRED INTERSECTION IMPROVEMENT ALTERNATIVE

Short-Term

Based on a review of existing traffic volumes and operating conditions at the Westford Road/Dunstable Road intersection, it is recommended that the short-term improvement strategy be pursued by the Town to provide an immediate benefit to operating conditions and safety at the intersection at relatively low cost while a funding source is identified for a long-term improvement measure.

Long-Term

Based on a review of existing and projected future traffic volumes and operating conditions at the Westford Road/Dunstable Road intersection and an evaluation of the motor vehicle crash history and associated crash patterns, Intersection Improvement Alternative 2 - *Westford Road Geometric Modifications*, was selected as the preferred intersection improvement alternative for the future long-term improvements. Implementation of this improvement strategy would achieve improved traffic operations (LOS “C” or better) with reduce vehicle queues and delays under 2020 Design-Year conditions. Further, the resulting increased intersection capacity and reduced motorist delay combined with improvements to the traffic signal system (equipment, timing and phasing) should also serve to reduce the frequency of occurrence of motor vehicle crashes at the intersection.

SUMMARY

VAI has completed an Intersection Safety and Operations Assessment for the intersection of Westford Road at Dunstable Road (a.k.a. Flint’s Corner) in Tyngsborough, Massachusetts. The purpose of this assessment was to evaluate potential improvement strategies for the intersection that would accomplish the following objectives: i) facilitate the efficient flow of vehicles, pedestrians and bicyclists; ii) accommodate existing and projected future traffic volumes; and iii) enhance safety at the intersection. The improvement strategies that have been identified for the subject intersection have been designed in accordance with MassDOT standards and follow MassDOT’s “Complete Streets” and “GreenDOT” design policies with respect to accommodating all roadway users. As such, the recommended improvements are designed to be eligible for funding through the State Transportation Improvement Program (STIP).

As a result of this assessment, it has been recommended that the Town’s *Lane Use Modification* design be implemented at the intersection of Westford Road at Dunstable Road as a short-term (immediate) improvement measure, and that Intersection Improvement Alternative 2 – *Westford Road Geometric Modifications*, be considered for implementation as a long-term improvement strategy in order to improve traffic operations and safety under both existing and projected future traffic volume conditions. Both

improvement strategies (short and long-term) include the development of an optimal traffic signal timing and phasing plan to accompany the recommended geometric modifications.

The estimated cost to design and construct the recommended improvements at the intersection is \$20,000 for the short-term improvement strategy and \$910,000 for the long-term improvement measures, excluding private property acquisition that may be associated with the long-term improvements.

cc: BG, File